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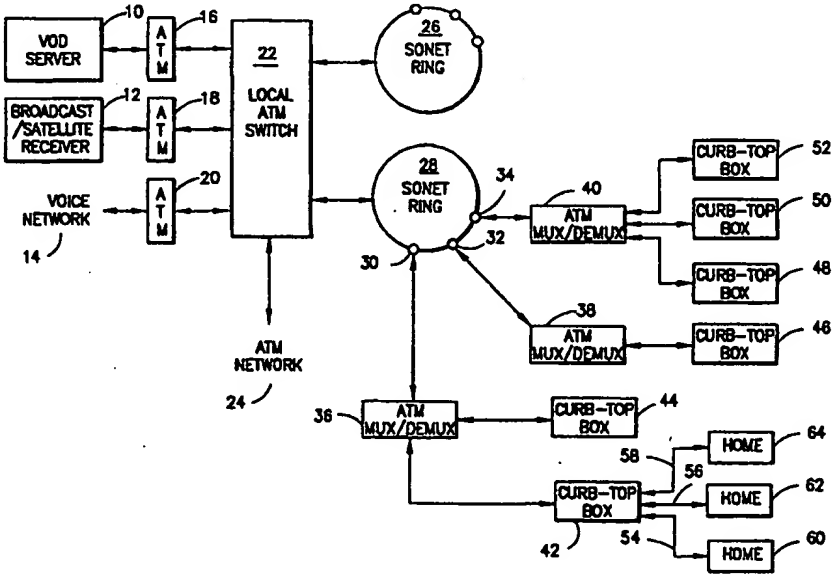

(57) Abstract

A method and apparatus for providing access to a large number of communications channels via a relatively narrow bandwidth conduit includes providing a fiber optic downlink conduit (28) from a programming source (10, 12, 14) to a "curb-top" box (42) and a fiber optic uplink conduit (28) from the curb-top box (42) to the programming source (10, 12, 14), and providing a plurality of relatively simple set-top boxes which are bidirectionally linked to the curb-top box (42) via existing coaxial cables (54). The curb-top box (42) is provided with the ability to access all of the channels carried by the downlink (28) and to rebroadcast selected channels as RF signals to the set-top boxes via the existing coaxial cables (54). The set-top boxes are each provided with the ability to send selection signals to the curb-top box via the coaxial cable (54) and to receive RF television signals from the curb-top box via the coaxial cable (54).

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METHOD AND APPARATUS FOR PROVIDING ACCESS TO A LARGE NUMBER OF COMMUNICATIONS CHANNELS VIA A RELATIVELY NARROW BANDWIDTH CONDUIT

BACKGROUND OF THE INVENTION

1. Field of the Invention

The invention broadly relates to telecommunications. More particularly, the invention relates to a method and apparatus for providing access to a large number of communications channels, in particular television channels, via a relatively narrow bandwidth conduit.

2. State of the Art

Cable television channels are transmitted as RF signals via coaxial cable to subscribers. All of the subscribers receive all of the channel signals simultaneously through the coaxial cable which is arranged as a read-only bus system. Each subscriber is provided with a tuner/decoder box ("set-top box") which is coupled to the coaxial cable and to the subscriber's television set. Typically, approximately forty television channels are simultaneously transmitted through the coaxial cable. While it is theoretically possible to transmit many more channels through a coaxial cable, practical limitations described below, limit the bandwidth of coaxial cable TV to about forty channels. Some of the channels, e.g. premium movie channels, may be encrypted or coded. The classic set-top box includes an RF receiver, a tuner, a transmitter, and a programmable decoder. The subscriber selects a channel with the tuner and the channel is transmitted via a cable connection from the set-top box to the subscriber's television set where it is received on channel 3 or 4. If the channel is coded or encrypted, the subscriber can only view the channel if the subscriber's set-top box is programmed to decode the channel.

When cable television systems were first introduced, they offered the ability to provide twenty-four or thirty-six channels

of television programming to every subscriber. Initially, there were not enough sources of programming to utilize all of the available channels. Today there are so many sources of television programming that cable television providers cannot supply all of the available sources to their subscribers. As mentioned above, the bandwidth of coaxial cable is limited in practice by the length of the cable, the number of leaks caused by splices, the noise introduced by repeating amplifiers and other factors. While it might be possible to transmit close to one hundred channels over a relatively short coaxial cable, the practical limit in cable TV systems is about forty channels. In order to expand the bandwidth of the cable television bus system, some cable television providers have installed a second parallel coaxial cable bus to double the channel capacity of the system. Modern set-top boxes accept two inputs and use an "A-B switch" to select from up to one hundred channels (fifty channels on each coaxial cable bus). However, with the constantly increasing number of new sources of television programming, it is expected that it will soon be necessary or desirable to provide subscribers with a selection of up to five hundred channels. Thus, cable television providers are exploring ways to increase further the channel capacity of the cable television system.

Modern set-top boxes are "addressable". The decoding and/or tuning capabilities of an addressable box may be affected by the signals it receives via the coaxial cable. In particular, each addressable box has a unique identification (address). The cable television provider can program the addressable box by transmitting the address of the box together with programming codes via the coaxial cable. The address and programming codes are actually received by every set-top box connected to the coaxial cable, i.e. all of the subscribers. However, only the box having the selected address will respond to the programming signals. The use of addressable boxes allows the cable television provider to program "pay-per-view" channels.

Pay-per-view programming operates according to a published schedule. A subscriber chooses to view a scheduled pay-per-view program by placing a telephone call to the cable television provider. The provider then transmits the appropriate address and programming codes to allow the subscriber's set-top box to decode the pay-per-view channel for the duration of the program. This represents the state of the art for most cable televisions systems.

The advantage of pay-per-view is that a subscriber need not pay for a monthly subscription to a "movie channel", but rather may pay for programs individually. It is potentially more convenient than renting a movie from a video store, but it has the substantial disadvantage that it is pre-scheduled.

The ideal pay-per-view programming system is known as "video-on-demand" or VOD. With VOD, a subscriber will be able to select a program from a published but unscheduled menu of programs to watch a selected program at any time the subscriber chooses. Unfortunately, conventional coaxial cable television systems are incapable of providing VOD programming. The subscribers are not directly connected to the provider by unique downlinks, but rather receive signals from a common bus. There is simply not enough bandwidth in the coaxial cable bus to provide unique channels for more than a few subscribers. Moreover, in order to provide a VOD service which has all of the advantages of a video tape rental, the subscriber must be able to pause, rewind, fast forward, etc. Therefore, each VOD subscriber must have a unique uplink to the provider in order to control the delivery of VOD. In order to provide VOD, therefore, the network architecture of a cable television system must be completely redesigned.

As mentioned above, the network architecture of a conventional cable television system is a read-only bus structure where all of the subscribers are coupled to the provider, and essentially to each other, by a single coaxial cable having many

branches. This is quite different from the network architecture of a telephone system, for example, where each subscriber is individually and bi-directionally connected to the service provider (the central office switch). The optimal VOD service would seem to require that each subscriber be individually and bidirectionally coupled to the service provider. Unfortunately, this would require a complete rewiring of a cable television system.

Because of the intense interest in VOD services, and the fact that these services seem to require an individual bi-directional link between subscriber and provider, local telephone companies are exploring ways to increase the bandwidth of their copper cable (twisted pair) network to provide a direct bi-directional video link to each customer with no loss or noise. The most promising approach to achieving this goal is to convert the composite analog video signal to a digital signal and to subject the digital signal to a data compression algorithm. The Motion Picture Experts Group (MPEG) was formed to standardize algorithms for digital video compression. The MPEG-2 algorithm allows a VCR quality video signal to be compressed to a bandwidth of approximately 6 Mbps (approximately the same bandwidth as analog broadcast video, but with the noise immunity of a digital signal). Utilizing a system known as Asymmetric Digital Subscriber Lines (ADSL), the bandwidth of existing telephone cables can be expanded to about 6 - 20 Mbps. It will be recognized that unlike the read-only bus system utilized by cable television systems, it is not necessary to transmit a large number of channels simultaneously in a system using direct bi-directional video links. Therefore, the use of telephone lines for cable television and VOD distribution is technologically feasible and commercially competitive with existing cable television systems.

In order to compete with the potential video offerings of local telephone companies, cable television systems are exploring fiber optics as a solution to the limited bandwidth of the read-

only coaxial cable bus system. For example, an "OC-12" fiber link is capable of delivering 622 Mbps. This is enough bandwidth for approximately 70 broadcast television channels in addition to approximately 16 VOD channels. Systems which carry fiber optic signals directly to a subscriber's home are referred to a Fiber to the Home ("FTTH") systems. These systems replace existing coaxial cable with fiber optic cable. New set-top boxes are provided which couple directly with the fiber optic cable and provide broad bandwidth bidirectional capabilities. Unlike coaxial cable, fiber optic cable requires special terminations if a single cable is designed to serve several set-top boxes in a single home.

It is widely appreciated, however, that the cost of replacing all of the existing coaxial cable with fiber optic cable is enormous. Recent efforts, therefore, have been directed toward integrating existing coaxial cable connections with new fiber optic distribution systems. One system of integrating existing coaxial cable connections with new fiber optic distribution systems is known as Hybrid Fiber Coax ("HFC"). HFC uses optical fiber to carry analog and/or digital signals to neighborhood distribution points in either a ring or a tree network. At each distribution point, existing coaxial cable is connected to the optical fiber by a distribution device which broadcasts television signals to a number of homes via the coaxial cable in a relatively conventional way. The difference between HFC and a normal cable-tv system is the number of subscribers per coaxial cable bus. By limiting the number of subscribers coupled to the distribution device, each provider can be allocated a portion of the coaxial cable bandwidth for VOD. Since the bandwidth of coaxial cable is relatively narrow, in order to serve a reasonable number of subscribers via the same cable bus system, sophisticated multiplexing techniques are used to enhance the bandwidth of the bus and these techniques rely on a sophisticated demultiplexing system in each subscriber's set-top box.

Another system which has been proposed eliminates all cable connections to the home by using a high frequency (40GHz) radio link to each subscriber from a fiber optic termination point. Each subscriber is assigned a dedicated frequency band for bidirectional communication and a relatively sophisticated unit in the home interfaces the high frequency transceiver with the subscriber's television sets.

Still another proposed system of integrating existing coaxial cable connections with new fiber optic distribution systems is known as Fiber to the Curb ("FTTC"). FTTC is similar to HFC, except that each subscriber home is linked to the neighborhood distribution device by a separate coaxial cable. Since the number of subscribers on a single coaxial cable bus is now limited to the number of set-top boxes in a single household, the need for sophisticated multiplexing of signals on the coaxial bus is virtually eliminated. Moreover, since the length of the coaxial cable connection from the household to the neighborhood distribution device is relatively short, the coaxial cable can carry a relatively broad bandwidth. The neighborhood distribution device need only remodulate the signals received from the fiber optic to signals which are placed on the relatively short coaxial cable bus. These signals may be analog or digital or a combination of analog and digital. The households will each be provided with new broadband bidirectional addressable set-top boxes which have access to the greater number of channels in a manner similar to existing set-top boxes. By making the boxes bidirectional, VOD channels can be provided. Thus, FTTC is similar in many ways to FTTH in that all of the channels enter the subscriber's home and are selected at the set-top box which includes all of the tuning/decoding and remodulating circuits needed to view any of the channels.

All of the presently explored systems incorporating fiber optics rely to a greater or lesser degree rely on the use of a sophisticated "set-top" box which interfaces directly with a relatively broad band signal conduit. Moreover, almost all of

the proposed systems rely on a fiber optic distribution system incorporating ATM. Thus, the ADSL system and the "wireless" systems described above also preferably rely on ATM and fiber optics because of the flexibility of ATM in distributing signals throughout a global network.

SUMMARY OF THE INVENTION

It is therefore an object of the invention to provide a method and apparatus for providing access to a large number of communications channels vis a relatively narrow bandwidth conduit.

It is also an object of the invention to provide a method and apparatus for integrating existing coaxial cable television conduits with wide bandwidth fiber optic conduits.

It is another object of the invention to provide a method and apparatus for delivering video on demand to cable television subscribers via existing coaxial cable television conduits.

It is still another object of the invention to provide an inexpensive set-top box for delivering video on demand channels to cable television subscribers.

It is also an object of the invention to provide an improved level of security in a cable television system wherein the possibility of theft of premium channel and pay-per-view services is virtually eliminated.

In accord with these objects which will be discussed in detail below, the method of the present invention includes providing a fiber optic downlink conduit from a programming source to a "curb-top" box (a communications channel server interface) and a fiber optic uplink conduit from the curb-top box to the programming source, and providing a plurality of relatively simple set-top boxes (communications channel client

interfaces) which are bidirectionally linked to the curb-top box via existing coaxial cables. The curb-top box is provided with the ability to access all of the channels carried by the downlink and to rebroadcast selected channels as RF signals to the set-top boxes via the existing coaxial cables. The set-top boxes are each provided with the ability to send selection signals to the curb-top box via the coaxial cable and to receive RF television signals from the curb-top box via the coaxial cable. The RF television signals may be sent directly to the subscriber's television set for tuning and demodulation, or the set-top box may include tuning, demodulating, and remodulating circuits.

According to a presently preferred method of the invention, the downlink to the curb-top box provides approximately 70 television channels and approximately 16 VOD channels as compressed digital signals. The uplink from the curb-top box provides control signals to the programming source for each of the VOD channels. Alternatively, a portion, e.g. 5% of the uplink and downlink bandwidth is reserved for telephony, and VOD channels are utilized for video telephony. As a further alternative embodiment, unused VOD channels are used to deliver additional broadcast programs when needed.

According to preferred aspects of the invention, the curb-top box is provided with at least one DAC for each set-top box so that when a channel is selected by a set-top box, the curb-top box selects that channel from the downlink, converts the digital signal to an analog signal and broadcasts the selected channel on a channel assigned to the set-top box and/or to the television set coupled to the set-top box. According to a presently preferred embodiment, the curb-top box serves approximately eight households or approximately thirty-two set-top boxes. In an example where each of eight households has four set-top boxes serving four televisions within the household, the curb-top box is provided with the ability to broadcast up to four simultaneous channels to each household on existing broadcast channels (e.g., 3,4,5,6 etc.). These channels may be directly accessed by each

television set by tuning each set to the appropriate channel. Alternatively, each set-top box may be arranged to rebroadcast the appropriate signal on channel 3 or 4 as is consistent with current practices.

An exemplary implementation of the invention includes an ATM switch for combining a plurality of programming sources, a plurality of SONET fiber rings coupled to the ATM switch, a plurality of ATM multiplexers coupled to each SONET fiber ring, and a plurality of curb-top boxes coupled to each ATM multiplexer. The curb-top boxes and the set-top boxes are preferably microprocessor driven. The set-top boxes may have microprocessors, but even simpler circuits could be used. As described above, up to four set-top boxes are served via a single coaxial cable bus coupled to a curb-top box; and up to thirty-two set-top boxes are served by a single curb-top box. This significantly reduces the cost of the set-top boxes and allows up to thirty-two television receivers to share the complex circuitry for converting digital fiber optic transmissions to analog RF transmissions. The arrangement of curb-top boxes and set-top boxes also precludes theft of cable services because the curb-top box determines what signals are sent to the set-top boxes and the workings of the cur-top box are accessible only to the service provider. Therefore, only authorized signals enter into the homes of subscribers. The downlink to each curb-top box is preferably an OC-12 fiber link and uplink from each curb-top box is preferably an OC-3 fiber link.

Additional objects and advantages of the invention will become apparent to those skilled in the art upon reference to the detailed description taken in conjunction with the provided figures.

BRIEF DESCRIPTION OF THE DRAWINGS

Figure 1 is a block diagram of one implementation of the method according to the invention;

Figure 2 is a block diagram of the connections between a curb-top box and a plurality of set-top boxes according to one embodiment of the invention;

Figure 3 is a block diagram of one embodiment of a curb-top box according to the invention;

Figure 4 is a block diagram of one embodiment of two set-top boxes in a single household according to the invention;

Figure 4a is a block diagram of a first alternative embodiment of a set-top box; and

Figure 4b is a block diagram of a second alternative embodiment of a set-top box.

DETAILED DESCRIPTION OF THE PREFERRED EMBODIMENTS

Referring now to Figure 1, the methods and apparatus according to the invention allow subscribers to access a relatively large number of communications channels via a relatively narrow bandwidth conduit. To that end, communications channels, including, e.g., a video on demand server 10, a television broadcast/satellite receiver 12, a telephone voice network 14, are processed via ATM switches 16, 18, 20 and delivered as ATM data to a local ATM switch 22 which is part of an ATM network 24. The ATM data is distributed over SONET fiber optics, e.g. 26, 28 to a plurality of nodes, e.g. 30, 32, 34. From the nodes, the ATM data is supplied via ATM multiplexers/demultiplexers, e.g. 36, 38, 40, to a plurality of curb-top boxes, e.g. 42, 44, 46, 48, 50, 52. Each curb-top box, e.g. 42 is coupled via existing coaxial cable 54, 56, 58 to the homes 60, 62, 64 of Cable TV subscriber. It will be appreciated that the ATM network 24 is a bidirectional data path and that at least some of the communications channels 10, 12, 14 will be bidirectionally coupled to the ATM network. As a practical matter, some of the communications channels, e.g. the television

broadcast/satellite receiver 12, may be unidirectionally coupled to the network, thereby providing data to the network without receiving any data from the network. Each curb-top box is bidirectionally coupled to the network, and each coaxial cable link 54, 56, 58 serves as a bidirectional data path between the curb top box 42 and a respective subscriber home 60, 62, 64.

Figure 2 is a more detailed view of the connections between the curb-top box 42 and subscriber households 60-64. As seen in Figure 2, the curb-top box 42 receives data from the network via a broad band OC-12 optical connection 42a and returns data to the network via an OC-3 optical connection 42b. Households 60-64 are coupled to the curb-top box 42 by respective existing coaxial cables 54-58. An existing coaxial cable, e.g. 54, may serve up to four television sets 160a-160d in household 60, each set being coupled to the cable 54 by a respective set-top box 260a-260d. As will be appreciated from the discussion which follows, the number of television sets served by the curb-top box and the number of set-top boxes coupled to a single coaxial cable bus may be varied according to design choice. The presently preferred embodiment envisions twenty to thirty-two set-top boxes served by a single curb-top box, and up to four set-top boxes served by a single coaxial cable bus.

Turning now to Figure 3, each curb-top box, e.g. 42, is preferably provided with an ATM switch 70 for interfacing with the digital network via the downlink 42a and the uplink 42b. The ATM switch 70 provides selected digital channels to an internal data bus 72. Groups of four digital-to-analog converters (DACs) 74a-d, 76a-d, etc., are coupled to the data bus 72, each DAC extracting a single data channel and converting the digital data to an analog signal. The outputs of each group of the DACs 74a-d, 76a-d, are coupled to respective RF modulators 78, 80 wherein the analog signal from each DAC is prepared for transmission via a respective coaxial cable. Each of the RF modulators 78, 80 is coupled via a respective interface 82, 84 to a respective coaxial cable 54, 55, which typically will be an existing cable-tv cable.

Each coaxial cable interface 82, 84 is also coupled to a respective control signal receiver 86, 88 for receiving control signals from the respective coaxial cables 54, 55. The control signals, which will be described in more detail below, are used to select which data channel from the downlink 42a is sent to which DAC 74a-d, 76a-d and also to send control signals to the uplink 42b. To this end, the control signal receivers 86, 88 are coupled to a microprocessor controller 90 and the controller 90 is coupled to each of the DACs 74a-d, 76a-d as well as to the ATM switch 70. Optionally, the control signal receiver 86 includes means for receiving an analog data signal which will be placed on the data bus 72 via an analog-to-digital converter 86a for transmission via the ATM switch 70 to the digital network. The operation of the curb-top box 42 is responsive to requests from the set-top boxes which are coupled to it.

Figure 4 illustrates the operation of two set-top boxes 260a, 260b which are coupled to a single coaxial cable bus 54 served by the curb-top box 42 described above. Each set-top box includes a tuner 262a, 262b for selecting one of the analog signals carried on the coaxial cable 54 and an RF modulator 264a, 264b for transmitting the selected signal to the RF section of a television set for reception on an unused local channel, typically channel 3 or 4. The tuner 262a, 262b is preferably coupled to and controlled by a microprocessor controller 266a, 266b which receives commands from a keypad 268a, 268b. The microprocessor controller 266a, 266b is also coupled to the cable 54 for sending control signals to the curb-top box 42. In one optional embodiment, the set-top box 260a may include a telephone voice circuit 270 for coupling the box to a telephone for telephone communications via the digital network. In another optional embodiment, the set-top box 260b may include audio/video circuitry 280 for coupling the box to a videophone for video telephony via the digital network.

Figures 4a and 4b illustrate alternative embodiments of set-top boxes. In the simplest and least expensive embodiment, shown

in Figure 4a, the set-top box 260c provides a direct coupling of the coaxial cable bus 54 to the television set. A request encoder 265c receives signals from the keypad 268c and transmits them via the coaxial cable bus 54 to the curb-top box. In this embodiment, the encoder 265c is identified by the curb-top box as requesting that certain programming be transmitted via the coaxial cable bus 54 on a particular channel, e.g. 3, 4, 5, 6, etc. The set-top box 260c indicates which channel the TV set should be tuned to in order to receive the programming requested by the keypad/encoder. In the embodiment of Figure 4b, a microprocessor 266d and a tuner 262d are responsive to signals from the keypad 268d. However, the tuner is only used for voice/videophone connections or for telecommunications connections to, e.g. the Internet. Video signals to the television set are transmitted directly from the curb-top box to the TV set on a particular channel, e.g. 3, 4, 5, 6, etc.

Referring now to Figures 1 - 4, 4a, and 4b the methods and apparatus according to the invention operate as follows: a plurality of communications channels are distributed to curb-top boxes 42-52 via the digital network 24, 26, 28. The curb-top boxes receive data via the downlink 42a and organize the data on an internal bus 72 for access by the DACs 74a-d, 76a-d, etc. A subscriber can access any of the communications channels by entering the appropriate command on the keypad 268a of the set-top box 260a. The command is processed by the controller 266a in the set-top box and sent via the coaxial cable 54 to the control signal receiver 86 in the curb-top box 42. The control signal is interpreted by the controller 90 in the curb-top box 42 which directs one of the DACs 74a-d to access the selected channel and convert the data therein to an analog signal. The analog signal is modulated by the RF modulator 78 and transmitted via the interface 82 onto the cable 54. The modulated RF signal is tuned by the tuner 262a in the set-top box 260a and remodulated by the RF modulator 264a so that it can be received by an attached television on an unused local channel such as channel 3 or 4. It will be appreciated that the number of analog signals modulated

on the cable 54 is limited only by the number of DACs which are coupled to the cable. In a presently preferred embodiment, four DACs 74a-d service each coaxial cable bus 54. This enables four televisions 160a-d in a single household 60 to display different programs at any given time. Alternatively, two televisions could each display two programs using "picture in picture" technology. It will be appreciated that in the simplest embodiment of the set-top box 260c, a subscriber can access any of the communications channels by entering the appropriate command on the keypad 268c. The command is processed by the encoder 265c in the set-top box and sent via the coaxial cable 54 to the control signal receiver 86 in the curb-top box 42. The control signal is interpreted by the controller 90 in the curb-top box 42 which directs one of the DACs 74a-d to access the selected channel and convert the data therein to an analog signal. The analog signal is modulated by the RF modulator 78 and transmitted via the interface 82 onto the cable 54 on a channel (e.g. 3, 4, 5, 6, etc.) which is assigned to the set-top box 260c so that it can be received by an attached television on the assigned channel.

It will be appreciated, that with respect to any single television set, only one analog signal is necessarily supplied to the cable 54 by the curb-top box 42. In other words, only one DAC is required for each television set serviced by the curb-top box. The set-top box provides the television set with full access to dozens or hundreds of channels although only one channel need be received. Changing channels involves sending a command to the curb-top box 42 to transmit a different channel via the DAC 74 and RF modulator 78 to the set-top box 260 and/or the attached TV set. While the presently preferred embodiment contemplates four DACs and thus four analog signals per cable bus, more or fewer could be used to allow more or fewer television sets to access the same cable bus. It is anticipated that up to thirty-two DACs will be provided in a curb-top box, although more or fewer are possible. The curb-top box may be configured in the field to provide different numbers of DACs for

each cable bus. Thus, if one household has two televisions, the cable bus to the that household may be coupled to only two DACs.

The methods and apparatus of the invention also permit the efficient delivery of VOD services. A subscriber chooses a VOD program in much the same way as choosing any other program as described above. In the case of VOD, however, the subscriber's command is relayed by the curb-top box 42 via the controller 90 through the ATM switch 70 back onto the digital network 24, 26, 28 where it is forwarded to the VOD server 10. The ATM switch 16 coupled to the VOD server 10 provides the appropriate header for the digital video data which is sent over the digital network and is received by the curb-top box 42 where it is transmitted to the set-top box 260 via the DAC 74 and RF modulator 78. Utilizing the keypad 268, the VOD user may pause, rewind, fast forward, or freeze the VOD display. These VCR-like commands issued by the user are transmitted back to the VOD server by the curb-top box.

It will further be appreciated that the range of communications channels served by the invention is not limited to television programming. The connection between the curb-top box and the set-top box may provide the subscriber with telephone service via the digital network. Videophone service may also be provided; and high speed data communication for Internet access and the like can also be provided by the invention using existing coaxial cables.

There have been described and illustrated herein methods and apparatus for providing access to a large number of communications channels via a relatively narrow bandwidth conduit. In particular, there have been described the use of curb-top and set-top boxes wherein existing coaxial cable is used to provide access to broad band fiber optic networks. While particular embodiments of the invention have been described, it is not intended that the invention be limited thereto, as it is intended that the invention be as broad in scope as the art will allow and that the specification be read likewise. Thus, while

portions of the invention have been described as "curb-top" and "set-top", it will be understood that these terms are used illustratively only and should not be considered limiting in any way. These portions of the invention need not be located near a curb or a set. Also, while particular network topographies have been disclosed, it will be appreciated that other network organizations could be utilized. Also, while microprocessor controllers have been shown, it will be recognized that other types of controllers could be used with similar results obtained and that the illustrated controllers may include other components deemed necessary or desirable by those skilled in the art. Moreover, while particular configurations have been disclosed in reference to DACs, modulators, interfaces, and ATM switches, it will be appreciated that other configurations could be used as well. Furthermore, while the set-top box has been disclosed as having a keypad, it will be understood that different types of input devices can achieve the same or similar function as disclosed herein; and that the input device may be in IR remote control device.

It will therefore be appreciated by those skilled in the art that yet other modifications could be made to the provided invention without deviating from its spirit and scope as so claimed.

Claims:

1. A method for providing access to a relatively large number of communications channels via a relatively narrow bandwidth conduit, said method comprising:

a) providing a first signal conduit from a television program source which includes a plurality of regularly scheduled television programs, said first signal conduit carrying the relatively large number of communications channels;

b) coupling a first communications channel server interface to said first signal conduit, said first communications channel interface receiving the relatively large number of communications channels;

c) coupling a plurality of relatively narrow bandwidth conduits to said communications channel server interface, each of said narrow bandwidth conduits being capable of carrying a smaller number of communications channels than said first signal conduit; and

d) coupling a plurality of communications channel client interfaces to one or more of said relatively narrow bandwidth conduits, said communications channel client interfaces each being capable of receiving at least one of the relatively large number of communications channels at a time and capable of transmitting a selection signal to said communications channel server interface, wherein

a communications channel client interface accesses at least one of the regularly scheduled television programs by transmitting said selection signal to said communications channel server interface via one of said relatively narrow bandwidth conduits, and, in response thereto, said communications channel server interface transmits a selected communications channel to said communications channel client interface.

2. A method according to claim 1, wherein:

a plurality of television sets are coupled to said first communications channel server interface via one or more of said relatively narrow bandwidth conduits,

each of said plurality of communications channel client interfaces corresponds to one of the plurality of television sets,

said communications channel server interface transmits said selected communications channel to said communications channel client interface on a television channel to which a corresponding one of the plurality of television sets is tuned.

3. A method according to claim 2, wherein:

up to four communications channel client interfaces and corresponding television sets are coupled to said communications channel server interface via a single narrow bandwidth conduit.

4. A method according to claim 1, wherein:

each of said relatively narrow bandwidth conduits is a coaxial cable.

5. A method according to claim 1, wherein:

said television program source includes video-on-demand programs, and

a communications channel client interface accesses a video-on-demand program from said television program source by transmitting said selection signal to said communications channel server interface via one of said relatively narrow bandwidth conduits, said communications channel server interface transmits a corresponding selection signal to said television program source, said television program source transmits a selected one of said video-on-demand programs from said television program source to said communications channel server interface, and said communications channel server interface transmits said selected one of said video-on-demand programs to said communications channel client interface.

6. A method according to claim 1, wherein:

said relatively large number of communications channels includes a plurality of telephony channels.

7. A method according to claim 5, wherein:

said relatively large number of communications channels includes approximately seventy television channels and approximately sixteen video-on-demand channels.

8. A method according to claim 1, wherein:

up to four communications channel client interfaces are coupled to said communications channel server interface via a single narrow bandwidth conduit.

9. A method according to claim 4, wherein:

said selection signal includes signals corresponding to VCR functions.

10. A system for providing access to a relatively large number of communications channels via a relatively narrow bandwidth conduit, said system comprising:

a) a first signal conduit carrying a relatively large number of communications channels including regularly scheduled television program channels from a television program source;

b) a first communications channel server interface coupled to said first signal conduit;

c) a plurality of communications channel client interfaces coupled to said first communications channel server interface via one or more relatively narrow bandwidth conduits, wherein

a communications channel client interface accesses at least one of the regularly scheduled television program channels by transmitting a selection signal to said communications channel server interface, and, in response thereto, said communications channel server interface transmits a selected communications channel to said communications channel client interface.

11. A system according to claim 10, wherein:

said television program source includes video-on-demand programs, and

a communications channel client interface accesses a video-on-demand program by transmitting said selection signal to said communications channel server interface via a relatively narrow bandwidth conduit, said communications channel server interface transmits a corresponding selection signal to said television program source, said television program source transmits a selected one of said video-on-demand programs to said communications channel server interface, and said communications channel server interface transmits said selected one of said video-on-demand programs to said communications channel client interface.

12. A system according to claim 10, wherein:

said relatively large number of communications channels includes a plurality of telephony channels.

13. A system according to claim 11, wherein:

said relatively large number of communications channels includes approximately seventy television channels and approximately sixteen video-on-demand channels.

14. A system according to claim 10, wherein:

up to four communications channel client interfaces are coupled to said communications channel server interface via a single narrow bandwidth conduit.

15. A system according to claim 11, wherein:

said selection signal includes signals corresponding to VCR functions.

16. A communications channel server interface for providing a plurality of communications channel client interfaces with access to a relatively large number of communications channels via relatively narrow bandwidth conduits coupling each of the client interfaces to said server interface, said server interface comprising:

a) receiving means for receiving the relatively large number of communications channels including regularly scheduled television program channels;

b) a plurality of transmitting means for transmitting a respective selected one of the large number of communications channels via a respective one of the relatively narrow bandwidth conduits to each of the client interfaces; and

c) selection means for receiving respective selecting signals via the relatively narrow bandwidth conduits from each of the client interfaces, wherein

each of said plurality of transmitting means is responsive to a respective selecting signal from a respective one of the client interfaces so that each of said plurality of transmitting means transmits said respective selected one of the large number of communications channels via the relatively narrow bandwidth conduits to each of the client interfaces.

17. A communications channel server interface according to claim 16, wherein:

said receiving means includes an ATM switch, and

each of said transmitting means includes a digital-to-analog converter.

18. A communications channel server interface according to claim 17, wherein:

each of said transmitting means includes an RF modulator.

19. A communications channel server interface according to claim 16, wherein:

the relatively large number of communications channels includes a plurality of video-on-demand channels provided by a video-on-demand server, and

each of said selection means includes control means for transmitting control signals to the video-on-demand server.

20. A communications channel server interface according to claim 16, wherein:

the relatively large number of communications channels includes a plurality of telephony channels, and

each of said selection means includes audio transmission means for transmitting audio signals from the client servers via the telephony channels.

21. A communications channel client interface for accessing a relatively large number of communications channels including regularly scheduled television program channels from a communications server interface via a relatively narrow bandwidth conduit, said client interface comprising:

a) receiving means for receiving a selected one of the relatively large number of communications channels from the server interface via the relatively narrow bandwidth conduit; and

b) selection means for transmitting a channel selection signal to the server interface via the relatively narrow bandwidth conduit, wherein

at least one of the regularly scheduled television program channels is accessed by transmitting a respective channel selection signal to the server interface via the relatively narrow bandwidth conduit.

22. A communications channel client interface according to claim 21, for use with a television receiver, wherein:

said receiving means includes means for coupling the relatively narrow bandwidth conduit to the television receiver.

23. A communications channel client interface according to claim 21, wherein:

said receiving means includes an RF tuner.

24. A communications channel client interface according to claim 21, wherein:

said selection means includes a microprocessor and an input device.

25. A communications channel client interface according to claim 21, wherein:

the relatively large number of communications channels includes a plurality of television channels, and

said receiving means includes an RF tuner.

26. A communications channel client interface according to claim 21, wherein:

the relatively large number of communications channels includes a plurality of video-on-demand channels provided by a video-on-demand server, and

said input device includes accepts input commands corresponding to VCR functions.

27. A communications channel client interface according to claim 26, wherein:

the relatively large number of communications channels includes a plurality of telephony channels, and

said selection means includes audio transmission means for transmitting audio signals from said client interface to the server interface.

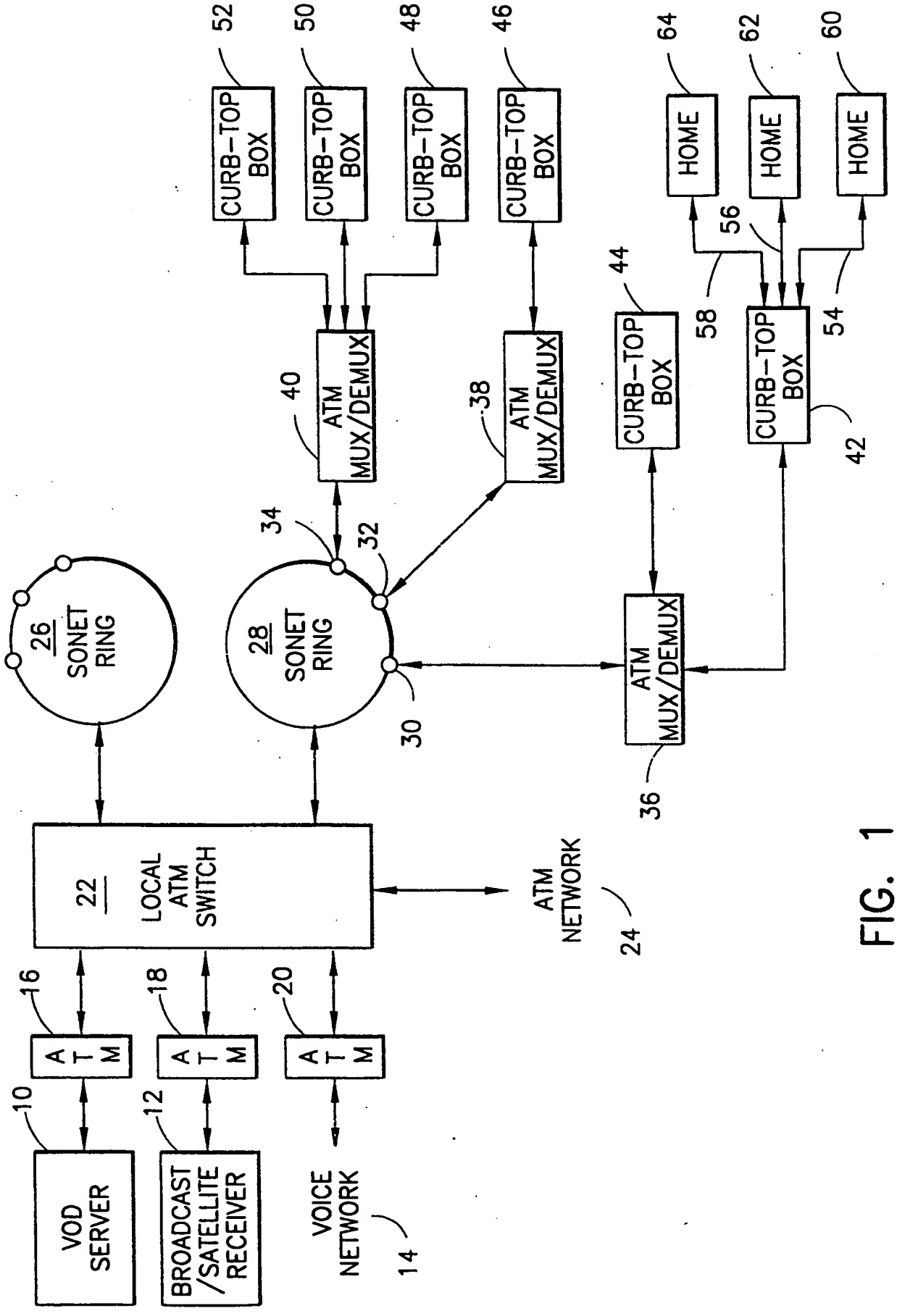
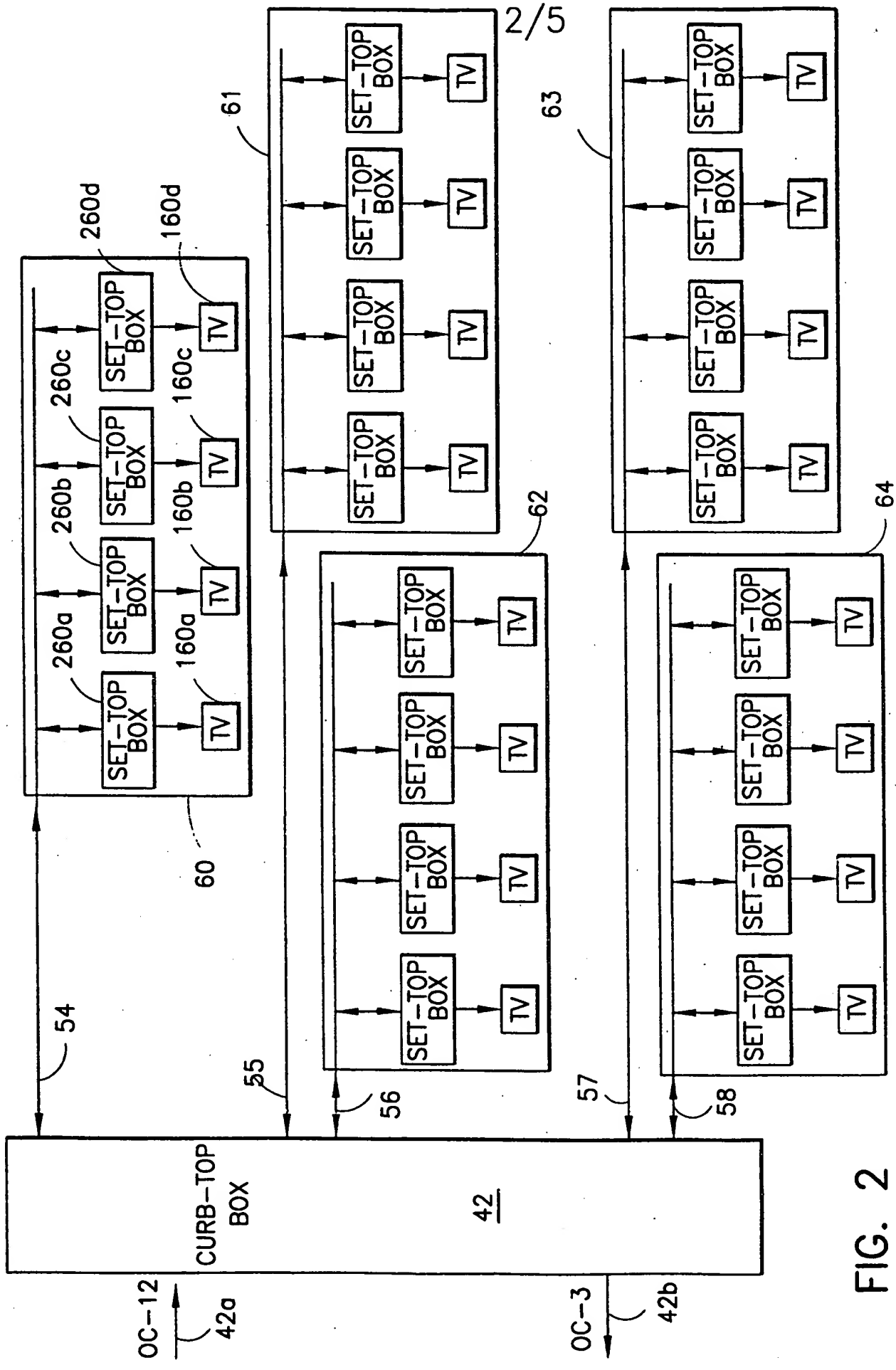

VOD SERVER
10
BROADCAST /SATELLITE RECEIVER
12
VOICE NETWORK
14
A T M
16
A T M
18
A T M
20
22 LOCAL ATM SWITCH
ATM NETWORK
24
26 SONET RING
28 SONET RING
30
32
34
ATM MUX/DEMUX
40
ATM MUX/DEMUX
38
ATM MUX/DEMUX
36
CURB-TOP BOX
52
CURB-TOP BOX
50
CURB-TOP BOX
48
CURB-TOP BOX
46
CURB-TOP BOX
44
CURB-TOP BOX
42
HOME
64
HOME
62
HOME
60
56
58
54

FIG. 1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OC-3
42b
54
55
56
57
58
60
61
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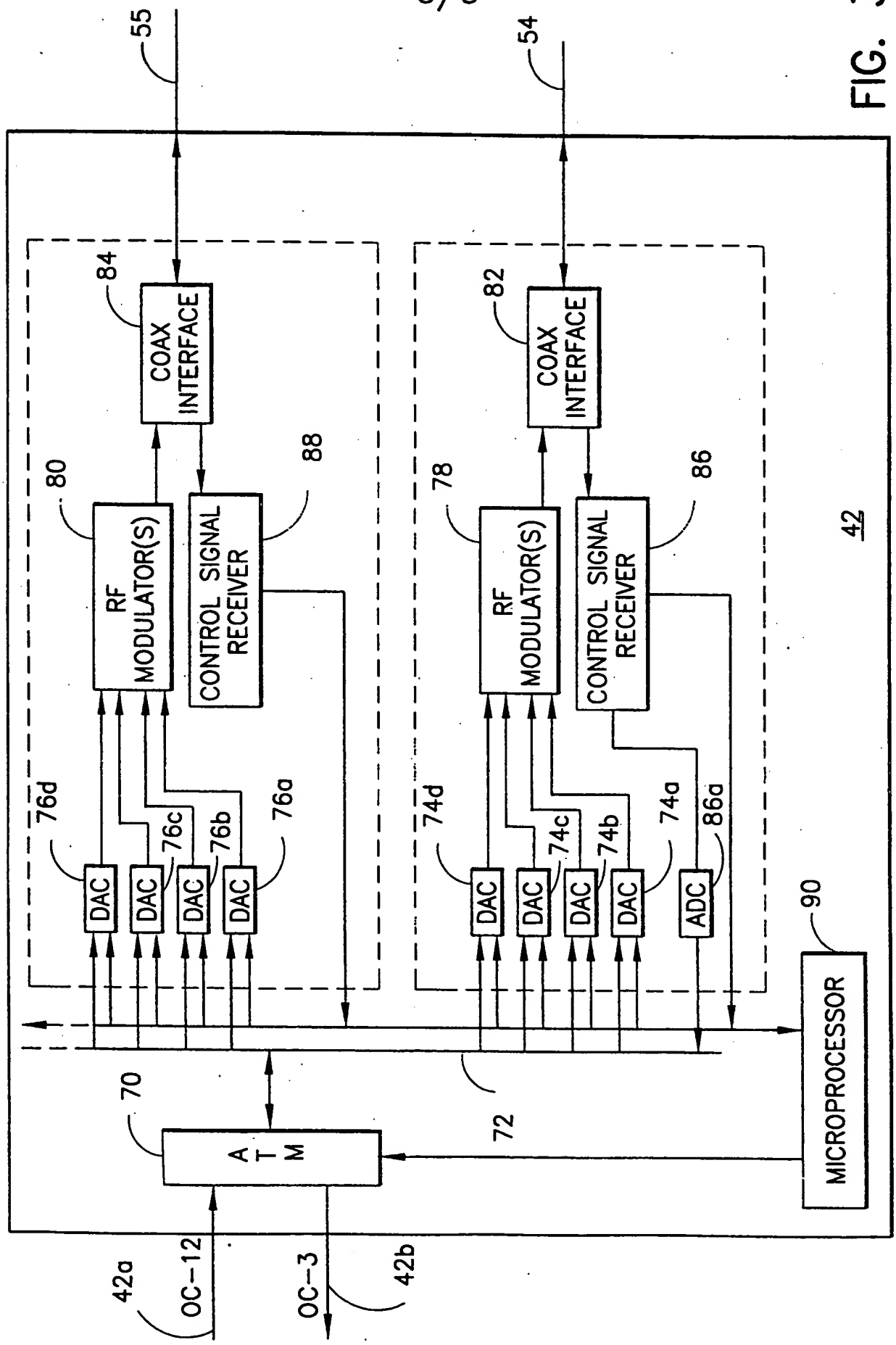
63
64
260a
260b
260c
260d
160a
160b
160c
160d
SET-TOP BOX
TV

FIG. 2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54
84
COAX INTERFACE
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COAX INTERFACE
80
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88
CONTROL SIGNAL RECEIVER
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CONTROL SIGNAL RECEIVER
42
76d
76c
76b
76a
DAC
DAC
DAC
DAC
74d
74c
74b
74a
86a
DAC
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ADC
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MICROPROCESSOR
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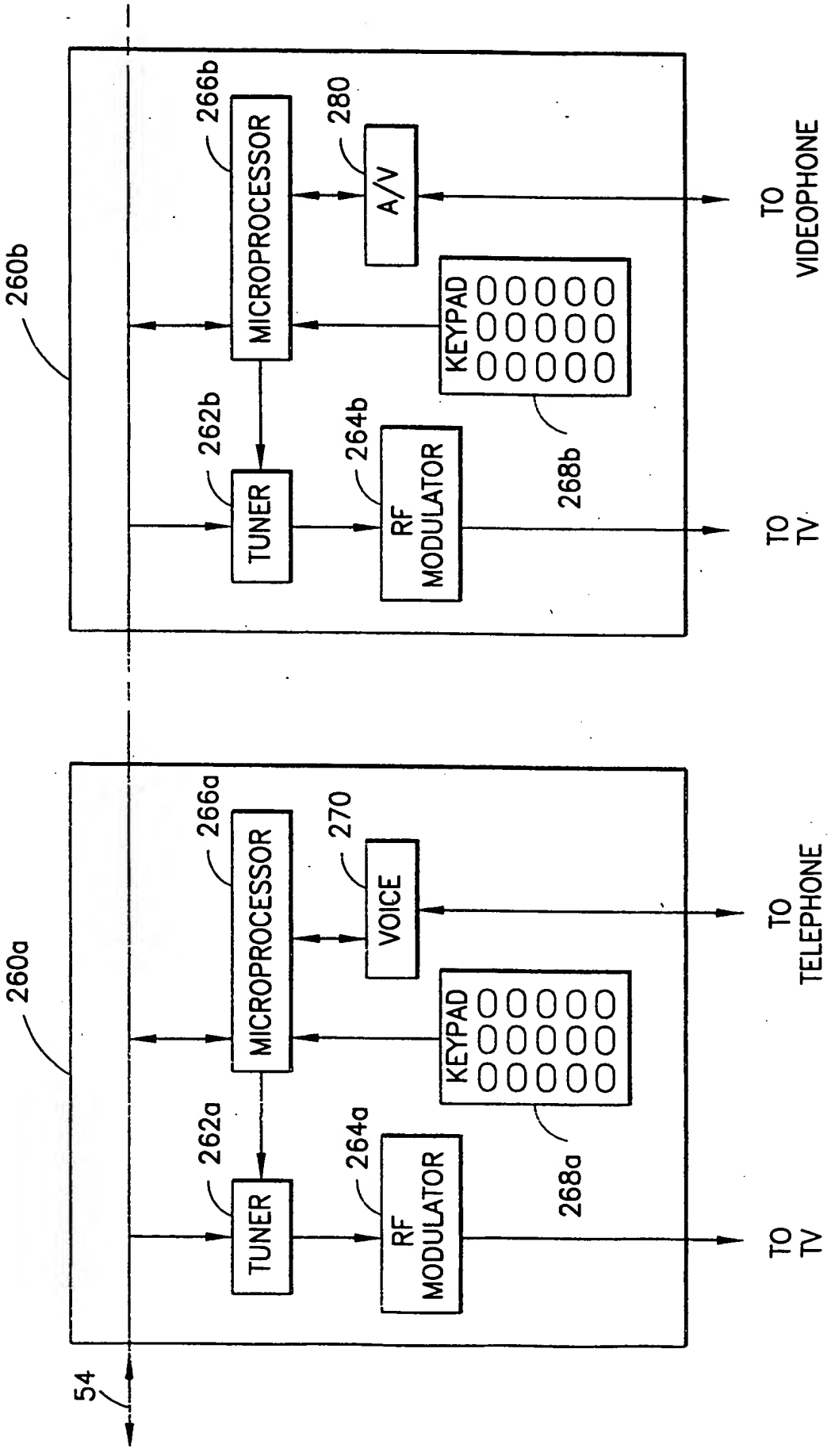
A T M
72
42a
OC-12
OC-3
42b

FIG. 3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MICROPROCESSOR
280
A/V
TO VIDEOPHONE
KEYPAD
262b
TUNER
264b
RF MODULATOR
268b
TO TV
260a
266a
MICROPROCESSOR
270
VOICE
TO TELEPHONE
KEYPAD
262a
TUNER
264a
RF MODULATOR
268a
TO TV
54

FIG. 4

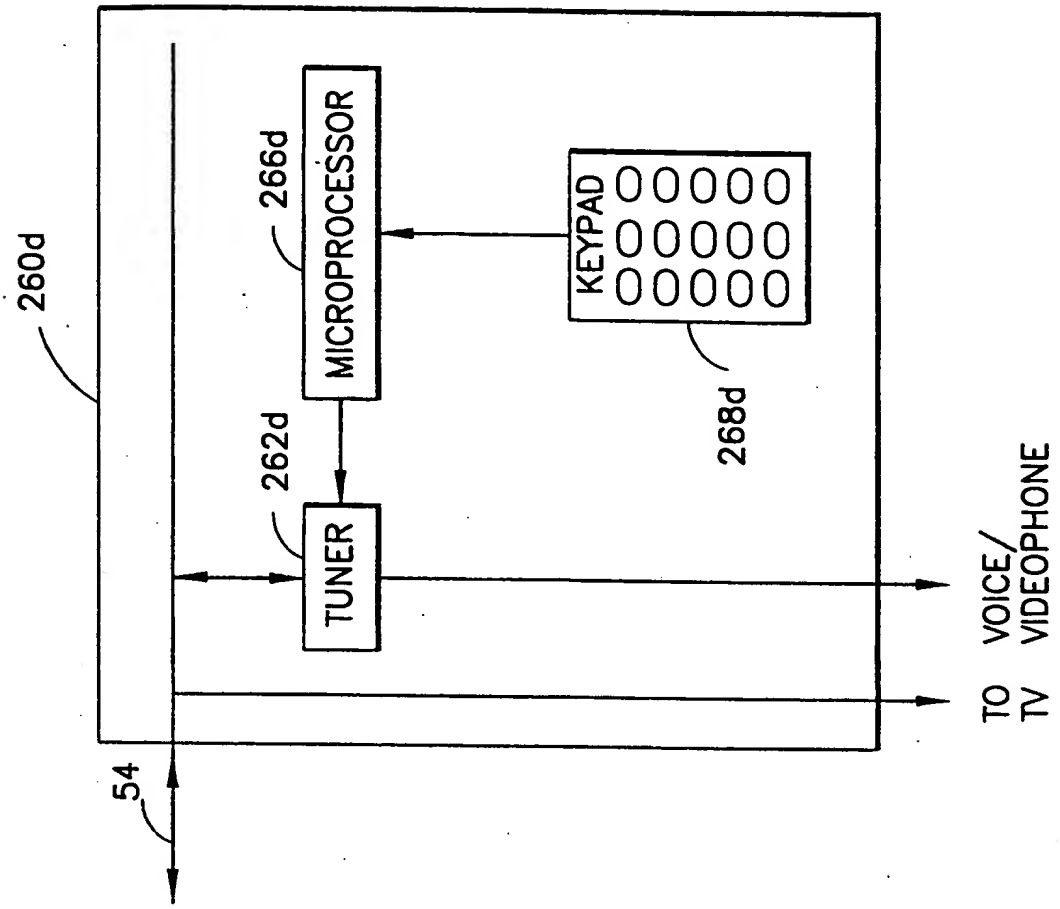
260d
266d
MICROPROCESSOR
KEYPAD
00000
00000
00000
268d
262d
TUNER
TO VOICE/ VIDEOPHONE
TO TV
54

FIG. 4b

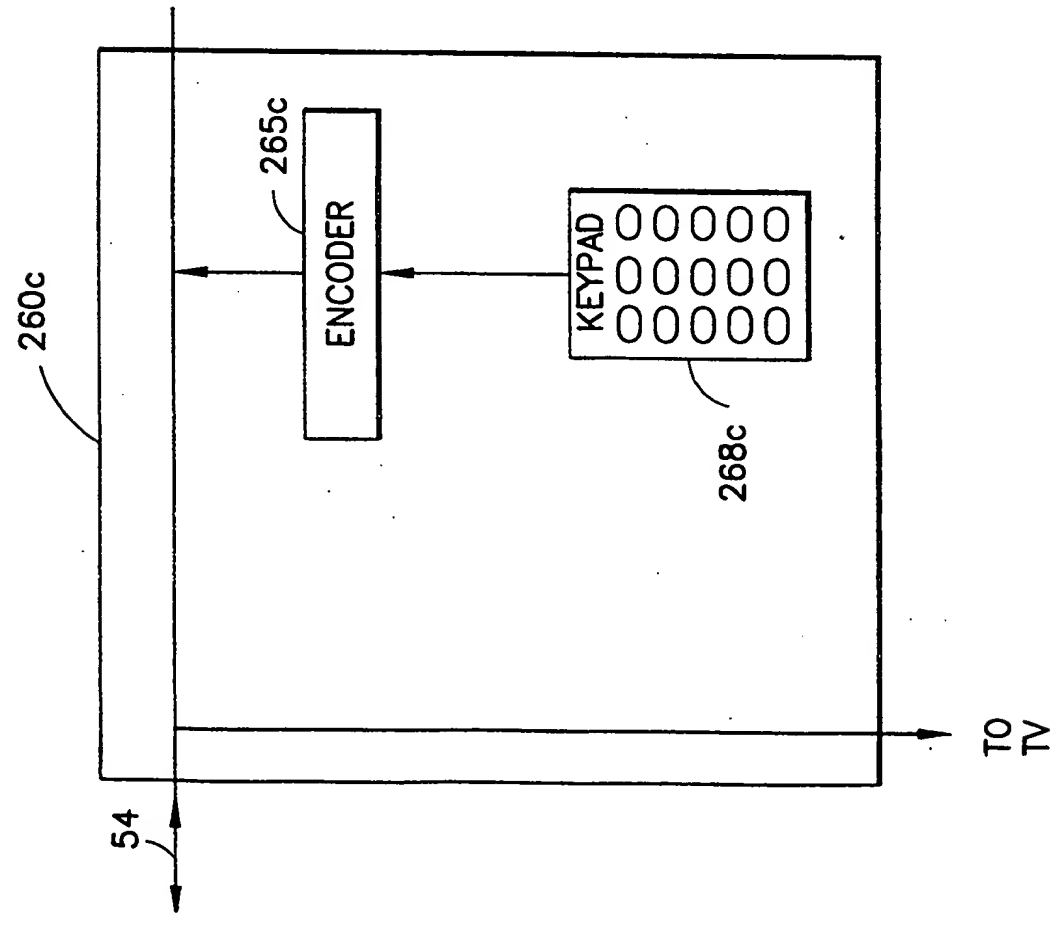
260c
265c
ENCODER
KEYPAD
00000
00000
00000
268c
TO TV
54

FIG. 4a

INTERNATIONAL SEARCH REPORT

International application No.
PCT/US96/10599

A. CLASSIFICATION OF SUBJECT MATTER

IPC(6) :H04N 7/10, 7/14; H04H 1/00
US CL :Please See Extra Sheet.
According to International Patent Classification (IPC) or to both national classification and IPC

B. FIELDS SEARCHED

Minimum documentation searched (classification system followed by classification symbols)

U.S. : 455/4.1, 4.2, 5.1, 6.1, 6.2; 348/7, 10, 12, 13, 14
H04N 7/10, 7/14; H04H 1/00

Documentation searched other than minimum documentation to the extent that such documents are included in the fields searched

Electronic data base consulted during the international search (name of data base and, where practicable, search terms used)

C. DOCUMENTS CONSIDERED TO BE RELEVANT

Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
X -- Y	US, A, 5,181,106 (SUTHERLAND) 19 January 1993, see whole document.	1-8, 10-14, 16-25 --- 9, 15, 26, 27
Y	US, A 5,357,276 (BANKER ET AL) 18 October 1994, see abstract.	9, 15, 26, 27

☐ Further documents are listed in the continuation of Box C. ☐ See patent family annex.

*	Special categories of cited documents:	"T"	later document published after the international filing date or priority date and not in conflict with the application but cited to understand the principle or theory underlying the invention
"A"	document defining the general state of the art which is not considered to be part of particular relevance	"X"	document of particular relevance; the claimed invention cannot be considered novel or cannot be considered to involve an inventive step when the document is taken alone
"E"	earlier document published on or after the international filing date	"Y"	document of particular relevance; the claimed invention cannot be considered to involve an inventive step when the document is combined with one or more other such documents, such combination being obvious to a person skilled in the art
"L"	document which may throw doubts on priority claim(s) or which is cited to establish the publication date of another citation or other special reason (as specified)	"&"	document member of the same patent family
"O"	document referring to an oral disclosure, use, exhibition or other means		
"P"	document published prior to the international filing date but later than the priority date claimed		

Date of the actual completion of the international search 25 SEPTEMBER 1996	Date of mailing of the international search report 15 OCT 1996
Name and mailing address of the ISA/US Commissioner of Patents and Trademarks Box PCT Washington, D.C. 20231 Facsimile No. (703) 305-3230	Authorized officer JOHN W. MILLER Telephone No. (703) 305-4700

Form PCT/ISA/210 (second sheet)(July 1992)*

INTERNATIONAL SEARCH REPORT

International application No.
PCT/US96/10599

A. CLASSIFICATION OF SUBJECT MATTER:
US CL :

455/4.2, 5.1; 348/7, 12, 14